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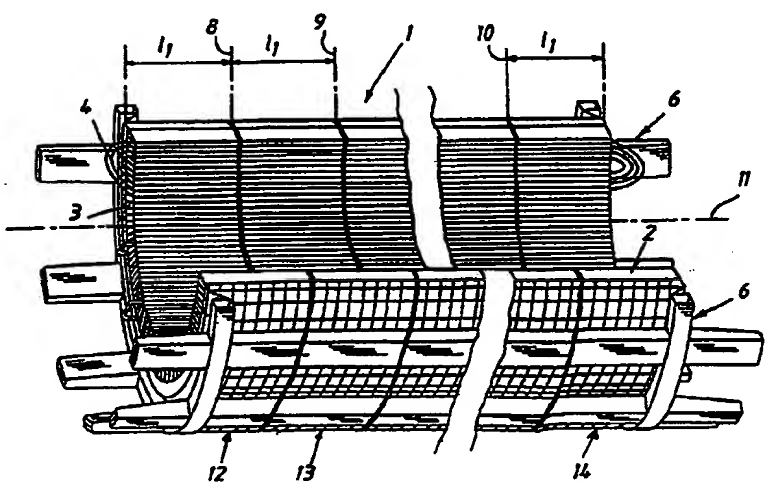

(57) Abstract

The present invention relates to a stator (1) for a rotating electric machine, comprising a stator frame (6), a stator core (2) and a winding (4) arranged in slots in said stator core, characterized in that said stator is built of at least two self-supporting stator elements (12, 13, 14; 18, 19; 27, 28, 29, 35, 36, 37) of a substantially annular disc shape, and that the axial length *l* of said stator elements is defined by one or more dividing planes (8, 9, 10; 20; 30, 31) perpendicular to the longitudinal axis (11; 21) of the stator. The invention also includes a method of manufacturing a stator and a rotating electric machine including such a stator.

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A STATOR AND A METHOD FOR MANUFACTURING A STATOR

The present invention relates to a stator for a rotating electric machine in accordance with the introductory part of claim 1, a method for manufacturing a stator for a rotating electric machine in accordance with the introductory part of claim 23, as well as a rotating electric machine in accordance with claim 31.

Examples of rotating electric machines which are relevant in the context of the present invention comprise synchronous machines, ordinary asynchronous machines, double-fed machines, applications for asynchronous converter cascades, external pole machines and synchronous flux machines, as well as alternating current machines, which primarily are intended to be used as generators in power stations for the generation of electric power.

In the following, mostly synchronous machines are discussed, but it should be noted that the present invention is not limited to such machines.

Most synchronous machines according to conventional prior art have a field winding in the rotor, where the main flux is generated by direct current, and an AC winding in the stator. Stator frames for large synchronous machines are often made of steel sheet with a welded construction. The laminated core is normally made from enamelled 0.35 or 0.5 mm electric sheet. For radial ventilation and cooling, the laminated core, at least for medium-size and large machines, is divided into stacks with radial ventilation ducts. For larger machines, the sheet is punched into segments, which are attached to the stator body by means of wedges/dovetails. The laminated core is retained by pressure fingers and pressure plates. The stator winding is disposed in slots in the laminated core, which normally have a cross section in the form of a rectangle or a trapezoid.

One major disadvantage with larger stator cores according to the prior art is the problem of manufacturing and also transporting such cores. According to convention,

the complete stator core, with the frame, is manufactured in a workshop. In order to be able to transport the stator core to the site of installation, the core is then divided along axial dividing planes into as few core sections as possible, with consideration taken to the transportation facilities. On the site of installation, the core sections are assembled and held together and secured by means of the stator frame, which may comprise several frame sections assembled together. The winding may be installed on the site or partly in the workshop. An alternative, especially for very large sized machines, is to perform more of the manufacturing steps of the stator core on the site of installation, including assembling the punched electric sheets of the core, assembling the core in the stator frame, but not including punching the sheets.

So called turbogenerators are considerably longer in relation to the diameter than other generators. They may have a length in the order of 6-7 m, but on the other hand their diameter is normally considerably smaller than that of other generators. Turbogenerators have higher demands on the rigidity and stiffness of the cross section of the core, since they normally are bipolar machines with a high rotation speed, and the natural frequency for the four node mode shape often ends up in the vicinity of 100-120 Hz for larger machines, which is close to the excitation frequency of a bipolar machine. This will often result in vibration problems.

Rotating electric machines have, according to conventional prior art, been designed for voltages in the interval 6-30 kV, where 30 kV normally has been regarded as an upper limit. In the case of a generator, this would normally mean that a generator must be connected to the power network via a transformer, which transforms the voltage up to the level of the power network, which will be in the range of 130-400 kV.

During the years, certain attempts have been made to develop especially synchronous machines, in particular generators, for higher voltages. Examples of this are described

in "Electrical World", October 15, 1932, pp 524-525, the article "Water-and-Oil-cooled Turbogenerator TVM-300" in J. Elektrotechnika, No. 1, 1970, pp 6-8, and the patent publications US 4,429,244 and SU 955 369. Unfortunately, none of these have been successful and they have not resulted in any commercially available products.

It appears, however, that it is possible to use high voltage insulated electric conductors with permanent insulation, similar to cables used for transmitting electric power (such as XLPE cables), as a stator winding in a rotating electric machine. Thereby, the voltage of the machine may be increased to such levels that it may be connected directly to the power network, without any intermediate transformer. Such an insulated conductor or cable is flexible and it is of a kind which is described more in detail in WO 97/45919 and WO 97/45847. Additional descriptions of the insulated conductor or cable concerned can be found in WO 97/45918, WO 97/45930 and WO 97/45931.

The object of the present invention is to solve the above mentioned problems and to provide a stator for a rotating electric machine of the above indicated type, which stator is designed in such a way that a new and very flexible manufacturing method will be made possible. The object is also to provide a manufacturing method for a stator as well as a rotating electric machine including the stator.

An additional object of the present invention is that the stator and the rotating electric machine should be suitable to be used for high voltages, by which is meant electric voltages primarily exceeding 10 kV. A typical working range for such a machine may be 36 - 800 kV, preferably 72,5 ÷ 800 kV.

The object is achieved by means of a stator including the advantageous features as defined in claim 1. A corresponding method is defined in claim 23. Finally, the object is also achieved by means of a rotating electric machine in accordance with claim 31, comprising a stator as defined in any one of the claims regarding the stator.

Accordingly, the stator of claim 1 is characterized in that said stator is built of at least two self-supporting stator elements of a substantially annular disc shape, and that the axial length of said stator elements is defined by one or more dividing planes perpendicular to the longitudinal axis of the stator. A stator with this design is consequently made up of a number of elements which also may be described as "slices". This design is particularly advantageous for turbogenerators since it offers a possibility of assembling the generator, preferably on site, of shorter elements which are much more easily transported. In order to make the disc elements self-supporting, their axial length is preferably more than 0.5 m. An ordinary turbogenerator may for example thus be divided into between 2-15 disc elements or slices, depending on the length of the generator. A likely size for a disc element may be 0.5 - 4 m. Generally, the number of disc elements into which the stator is divided depends on where one chooses to set the limit for the length, primarily with regard to easy transportation and general handling of the elements.

The corresponding method is characterized in axially joining together at least two self-supporting stator elements of a substantially annular disc shape, the axial length of said stator elements being defined by one or more dividing planes perpendicular to the longitudinal axis of the stator.

The design of the stator according to present invention will also make it possible to construct much larger, longer, and heavier generators, since the transportation is much facilitated.

To continue, to make the disc elements self-supporting is not only an advantage from a transportation point of view but is also an important feature in order to make the generator able to withstand the dynamic conditions during operation and to avoid vibrations.

As a further feature of the stator defined in claim 1, according to the present invention, the winding is provided by means of an insulated conductor which comprises at

least one current-carrying conductor, a first layer having semiconducting properties provided around said conductor, a solid insulating layer provided around said first layer, and a second layer having semiconducting properties provided around said insulating layer. The method defined in claim 23 includes the corresponding feature.

As mentioned above, the windings, according to the invention, are preferably of a type corresponding to cables having solid, extruded insulation, of a type now used for power distribution, such as XLPE-cables or cables with EPR-insulation. Such a cable comprises an inner conductor composed of one or more strand parts, an inner semiconducting layer surrounding the conductor, a solid insulating layer surrounding this and an outer semiconducting layer surrounding the insulating layer. Such cables are flexible, which is an important property in this context since the technology for the stator and method according to the invention is based primarily on winding systems in which the winding is formed from cable which is bent during assembly. The flexibility of an XLPE-cable normally corresponds to a radius of curvature of approximately 20 cm for a cable with a diameter of 30 mm, and a radius of curvature of approximately 65 cm for a cable with a diameter of 80 mm. In the present application the term "flexible" is used to indicate that the winding is flexible down to a radius of curvature in the order of four times the cable diameter, preferably eight to twelve times the cable diameter.

The winding should be constructed to retain its properties even when it is bent and when it is subjected to thermal or mechanical stress during operation. It is vital that the layers retain their adhesion to each other in this context. The material properties of the layers are decisive here, particularly their elasticity and relative coefficients of thermal expansion. In an XLPE-cable, for instance, the insulating layer consists of cross-linked, low-density polyethylene, and the semiconducting layers consist of polyethylene with soot and metal particles mixed in. Changes in

volume as a result of temperature fluctuations are completely absorbed as changes in radius in the cable and, thanks to the comparatively slight difference between the coefficients of thermal expansion in the layers in relation to the elasticity of these materials, the radial expansion can take place without the adhesion between the layers being lost.

The material combinations stated above should be considered only as examples. Other combinations fulfilling the conditions specified and also the condition of being semiconducting, i.e. having resistivity within the range of 10^{-1}-10^{6} ohm-cm, e.g. 1-500 ohm-cm, or 10-200 ohm-cm, naturally also fall within the scope of the invention.

The insulating layer may consist, for example, of a solid thermoplastic material such as low-density polyethylene (LDPE), high-density polyethylene (HDPE), polypropylene (PP), polybutylene (PB), polymethyl pentene ("TPX"), cross-linked materials such as cross-linked polyethylene (XLPE), or rubber such as ethylene propylene rubber (EPR) or silicon rubber.

The frist, inner, and the second, outer, semiconducting layers may be of the same basic material but with particles of conducting material such as soot or metal powder mixed in.

The mechanical properties of these materials, particularly their coefficients of thermal expansion, are affected relatively little by whether soot or metal powder is mixed in or not - at least in the proportions required to achieve the conductivity necessary according to the invention. The insulating layer and the semiconducting layers thus have substantially the same coefficients of thermal expansion.

Ethylene-vinyl-acetate copolymers/nitrile rubber (EVA/NBR), butyl graft polyethylene, ethylene-butyl-acrylate copolymers (EBA) and ethylene-ethyl-acrylate copolymers (EEA) may also constitute suitable polymers for the semiconducting layers.

Even when different types of material are used as base in the various layers, it is desirable for their coefficients of thermal expansion to be substantially the same. This is the case with the combination of the materials listed above.

The materials listed above have relatively good elasticity, with an E-modulus of E<500 MPa, preferably <200 MPa. The elasticity is sufficient for any minor differences between the coefficients of thermal expansion for the materials in the layers to be absorbed in the radial direction of the elasticity so that no cracks appear, or any other damage, and so that the layers are not released from each other. The material in the layers is elastic, and the adhesion between the layers is at least of the same magnitude as in the weakest of the materials.

The conductivity of the two semiconducting layers is sufficient to substantially equalize the potential along each layer. The conductivity of the outer semiconducting layer is sufficiently high to enclose the electrical field within the cable, but sufficiently low not to give rise to significant losses due to currents induced in the longitudinal direction of the layer.

Thus, each of the two semiconducting layers essentially constitutes one equipotential surface, and these layers will substantially enclose the electrical field between them.

There is, of course, nothing to prevent one or more additional semiconducting layers being arranged in the insulating layer.

Through the use of high voltage insulated electric conductors, the voltage of the machine may be increased to such levels that it may be directly connected to the power network without passing over a transformer. This leads to the very important advantage that the conventional transformer may be eliminated. Consequently, the solution according to the present invention represents major savings both in economic terms and regarding space requirement and weight for

generator plants and other installations comprising rotating electric machines.

Other advantages and features of the present invention will be apparent from the dependent claims.

According to a preferred embodiment each stator element includes a self-supporting stator core element. According to another feature each stator element further includes a self-supporting stator frame element. It should be noted that it is not required that the stator frame constitutes a part of the self-supporting stator elements of the main claim, since the stator elements may very well comprise only stator core elements and the stator frame may be installed later, on the site of operation.

The stator core elements may be made in a conventional manner by means of an optional number of layers of electric sheet, preferably glued together, or they may be made of a compacted metallic powder, a composite material including a magnetic powder or any other suitable material.

The stator is advantageously provided with assembling means for assembling the self-supporting stator elements. In one preferred embodiment, these assembling means may include bolts arranged to be applied in corresponding axial holes in the stator core elements. Preferably these bolts are provided with some pretensioning means in order to firmly secure the stator elements together. Said bolts may be combined bolts and cooling ducts. Said bolts may also be combined bolts and slot key elements.

Alternatively, said assembling means may comprise welding the stator elements together, or comprise an adhesive.

In another preferred embodiment, the assembling means may comprise a flange joint applied externally on the stator frame, which in such a case also would be divided into frame parts. Naturally, more than one flange joint is normally required, the number depending on the length of the stator and the number of stator elements.

According to a particularly important feature the stator is provided with first guiding means for guiding the stator slots of one stator core element to fit the stator slots of an adjacent stator core element. According to another important feature the stator core elements are provided with holes for cooling ducts and the stator is provided with second guiding means for guiding the cooling duct holes of one stator core element to fit the cooling duct holes of an adjacent stator core element. These guiding means are very advantageous when the stator is in a turbogenerator, since a turbogenerator may have rather long stator elements. Long stator elements entail high demands on tolerances for the winding slots and holes for cooling ducts in order to avoid damages to the winding and the cooling ducts when they are inserted into the slots/holes, and the provided guiding means will ensure a good correspondence between the slots/holes in two adjacent stator core elements. An example of a guiding element for the cooling ducts would be a short sleeve partly inserted into one stator core, said sleeve functioning as a guiding means when the adjacent stator core is installed. The guiding means may well be of a type which is retracted when the assembling is completed or they may be of a kind which may remain in the core after completed assembly.

The cooling ducts may comprise preinstalled, substantially axial, cooling ducts in the stator core. In such a case sealing members, such as "O-rings", may be provided in the surfaces along the dividing planes.

The cooling ducts as well as the winding slots may be skewed in shape or a straight axial shape.

Concerning the insulated conductor in the winding, this may be provided with a number of advantageous features.

According to a preferred embodiment the insulated conductor or cable is flexible. This feature is important in order to be able to use the cable as a winding. To continue, the first semiconducting layer is substantially at the same potential as the current-carrying conductor. The second semiconducting layer is preferably arranged to constitute a

substantially equipotential surface surrounding said conductor and insulation layer. It is also connected to a predetermined potential, preferably ground potential. According to other features at least two adjacent layers have substantially equal thermal expansion coefficients; the current-carrying conductor may comprise a number of strands of which only a few are uninsulated from each other.

As a further advantage, each of said three layers, i.e. the two semiconducting layers and the insulation layer, may be solidly connected to the adjacent layer along substantially the whole connecting surface. According to yet another, particularly important feature, said layers are arranged to adhere to one another even when the insulated conductor or cable is subjected to bending. Finally, it may be mentioned that the cable by preference has a diameter in the interval 20-250 mm and a conducting area in the interval of 80-3000 mm^2.

Preferably, cables with a circular cross section are used. They have the advantage of bending more easily as well as displaying better electric properties. However, in order to obtain, among other things, better packing density, cables with a different cross section may be used.

The method according to the present invention advantageously further includes the step of axially assembling the stator elements by means of bolts being inserted into corresponding holes provided in the stator elements, which preferably are stator core elements. Alternatively the stator elements are axially assembled by means of at least one axial flange joint being applied externally on the stator frame.

Further steps includes inserting cooling ducts in corresponding holes provided in the stator and inserting the winding into the winding slots of the stator teeth. Preferably the winding is inserted axially into the winding slots. This is a simplified method of inserting the winding which is made possible by the type of flexible cable that is used. As yet an advantageous feature, the stator may be assembled on the site of installation of the rotating electric machine.

As a summary, the present invention has the advantage that it provides a stator core that is both simple with regard to the manufacturing method and easy to transport and install on the final site of operation. This is particularly advantageous for use in turbogenerators, but it is naturally not limited to such generators.

The invention will now be described in detail with reference made to preferred embodiments illustrated in the enclosed drawings, in which:

- Fig. 1 shows a partial schematic view in perspective of a stator according to the present invention,
- Fig. 2 shows a schematic view of a stator with a first embodiment of assembling means,
- Fig. 3 shows a schematic view of a stator with a second embodiment of assembling means, and
- Fig. 4 shows a cross section of an insulated electric conductor.

In figure 1 is illustrated a stator 1 according to the present invention, with a portion cut away for clarity reasons. This stator includes a stator core 2 and a stator frame 6. The stator core is built of stator teeth 3 and is provided with a schematically illustrated winding 4. In the illustrated exemplifying embodiment the stator is divided, along a number of dividing planes (of which only three are 8, 9, 10 are represented in figure 1), perpendicular to the longitudinal axis 11 of the stator, into a number of self-supporting stator elements, of which only three stator elements 12, 13, 14 are shown entirely. As illustrated, the number of dividing planes and the number of stator elements may be any number deemed suitable according to the preferences of the manufacturer, the user, etc. It is believed that most frequently it will be transportation limitations that are decisive when determining the number of elements, based on the maximum axial length ℓ of each element that may be transported.

Each of these stator elements 12, 13, 14 comprises a stator core element and a stator frame element. The dividing

planes are in the illustrated embodiment dividing the stator into stator elements of equal size, i.e. equal axial length ℓ_1. However, a division into elements of different axial lengths is naturally also conceivable. For example, it may be preferable to have stator elements of equal weight instead of equal axial length.

The stator may be described as if it was sliced into three slices, where each slice, i.e. stator element, is of a substantially disc shape. Of course the end elements are, in the represented embodiment which includes the frame, provided with protruding frame elements but this does not adversely affect the general impression of a disc shape.

In the following figures, elements similar to elements in Fig. 1 have been designated with the same reference numerals.

In figure 2 is illustrated a first embodiment of assembling means for the stator core 15, in the form of bolts 16 inserted into holes arranged in the core. These bolts are preferably provided with some sort of pretensioning means. The stator core is divided into two stator core elements 18, 19 by means of the dividing plane 20. In this case, the core elements are illustrated with an equal axial length ℓ_3. It should be noted that in this schematic illustration the core is represented as being much shorter, in comparison with its diameter, than what would normally be the case. The core also includes a cooling duct 17.

The stator 25 illustrated in figure 3 is divided into three stator elements 27, 28, 29 along two dividing planes 30, 31. In this exemplifying embodiment the stator elements are of different axial lengths, the two end elements being of a longer axial length ℓ_5 than the centre element, which has the axial length ℓ_4. The stator frame is correspondingly divided into three supporting frame parts 35, 36, 37, for support against part of the external peripheral surface of the stator core, as well as part of the axial ends of the core. The elements are assembled axially by means of two flange joint devices 33, 34 provided on the supporting

frame parts 35, 36, 37. Accordingly, the frame parts are provided with flanges at their respective adjoining ends, which are connected by means of screws or bolts. The flanges may be welded to the frame parts or fastened in any other suitable way.

Finally, in figure 4 is represented a cable which is particularly suitable to be used as a winding in the stator according to the invention. The cable 40 includes at least one current-carrying conductor 41 surrounded by a first semiconducting layer 42. Outside said first layer is provided a layer of solid insulation 43. Surrounding the insulation layer is then provided a second semiconducting layer 44. The current-carrying conductor may include a number of strands 46, of which at least some are insulated from each other. The three layers of the cable are arranged to adhere to each other even when the cable is bent. The cable is consequently flexible and this property is maintained during the entire life of the cable. The illustrated cable also differs from conventional high voltage cables in that it does not have to include any outer layer for mechanic protection of the cable, nor does it have to include any metal shield which normally is provided on such a cable.

The above description of preferred embodiments of the invention is only intended as illustrating examples, without limiting the invention. A number of modifications of the present invention may naturally be conceivable within the scope of the following patent claims.

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Patent claims

1. A stator (1) for a rotating electric machine, comprising a stator frame (6), a stator core (2) and a winding (4) arranged in slots in said stator core, wherein said stator is built of at least two self-supporting stator elements (12, 13, 14; 18, 19; 27, 28, 29, 35, 36, 37) of a substantially annular disc shape, wherein the axial length ℓ of said stator elements is defined by one or more dividing planes (8, 9, 10; 20; 30, 31) perpendicular to the longitudinal axis (11; 21) of the stator, and wherein said winding is provided by means of an insulated conductor (40) which comprises at least one current-carrying conductor (41), a first layer (42) having semiconducting properties provided around said conductor, a solid insulating layer (43) provided around said first layer, and a second layer (44) having semiconducting properties provided around said insulating layer.

2. A stator according to claim 1, **characterized** in that each stator element includes a self-supporting stator core element (18, 19; 27, 28, 29) of a substantially annular disc shape.

3. A stator according to claim 2, **characterized** in that each stator element further includes a stator frame element (35, 36, 37) corresponding to the stator core element.

4. A stator according to any one of claims 2-3, **characterized** in that each stator core element is made of an optional number of layers of electric sheet.

5. A stator according to any one of claims 2-3, **characterized** in that each stator core element is made of a compacted metallic powder.

6. A stator according to any one of claims 2-3, **characterized** in that each stator core element is made of a composite material including a magnetic powder.

7. A stator according to any one of the preceding claims, **characterized** in that it is provided with assembling means (6; 33, 34) for assembling the self-supporting stator elements.

8. A stator according to claim 7, **characterized** in that the assembling means includes bolts (16) being inserted into corresponding axial holes arranged in the stator elements (18, 19).

9. A stator according to claim 7, **characterized** in that the assembling means comprise an flange joint device (33, 34) applied externally on the stator frame (35, 36, 37).

10. A stator according to any one of claims 2-9, **characterized** in that it is provided with first guiding means for guiding the stator slots of one stator core element to fit the stator slots of an adjacent stator core element.

11. A stator according to any one of claims 1-10, **characterized** in that the winding slots are skewed.

12. A stator according to any one of claims 2-11, **characterized** in that the stator core elements (18, 19) are provided with holes (17) for cooling ducts and that the stator is provided with second guiding means for guiding the cooling duct holes of one stator core element to fit the cooling duct holes of an adjacent stator core element.

13. A stator according to claim 12, **characterized** in that it comprises preinstalled, substantially axial, cooling ducts in the stator core.

14. A stator according to claim 13, **characterized** in that the cooling ducts are skewed.

15. A stator according to any one of the preceding claims, **characterized** in that the stator winding is provided by means of a cable, preferably a high voltage cable.

16. A stator according to any one of the preceding claims, **characterized** in that said insulated conductor (40) or said cable is flexible.

17. A stator according to any one of the preceding claims, **characterized** in that said second layer (44) is arranged to constitute a substantially equipotential surface surrounding said conductor.

18. A stator according to any one of the preceding claims, **characterized** in that said second layer (44) is connected to a predetermined potential.

19. A stator according to claim 18, **characterized** in that said predetermined potential is ground potential.

20. A stator according to any one of the preceding claims, **characterized** in that at least two adjacent layers (42, 43, 44) have substantially equal thermal expansion coefficients.

21. A stator according to any one of the preceding claims, **characterized** in that each of said three layers (42,43,44) is solidly connected to the adjacent layer along substantially the whole connecting surface.

22. A stator according to any one of the preceding claims, **characterized** in that said layers (42, 43, 44) are arranged to adhere to one another even when the insulated conductor or cable is subjected to a bending force.

23. A method for use in the manufacturing of a stator for a rotating electric machine, comprising a stator, a rotor, and a stator winding, including the following steps:

- axially joining together at least two self-supporting stator elements (12, 13, 14; 18, 19; 27, 28, 29, 35, 36, 37) of a substantially annular disc shape, the axial length ℓ of said stator elements being defined by one or more dividing planes (8, 9, 10; 20; 30, 31) perpendicular to the longitudinal axis (11, 21) of the stator, in order to build the stator, and
- providing a winding by means of an insulated conductor (40) which comprises at least one current-carrying conductor (41), a first layer (42) having semiconducting properties provided around said conductor, a solid insulating layer (43) provided around said first layer, and a second layer (44) having semiconducting properties provided around said insulating layer.

24. A method according to claim 23, **characterized** in axially assembling the stator elements by means of bolts (16) being inserted into corresponding holes provided in the stator elements, which preferably are stator core elements (18, 19).

25. A method according to claim 23, **characterized** in axially assembling the stator elements by means of at least one flange joint device (33, 34) being applied externally on the stator frame (35, 36, 37).

26. A method to any one of claims 23-25, **characterized** in inserting cooling ducts in corresponding holes provided in the stator core.

27. A method according to any one of claims 23-26, **characterized** in inserting the winding into the winding slots of the stator core.

28. A method according to claim 27, **characterized** in that the winding is inserted axially into the winding slots.

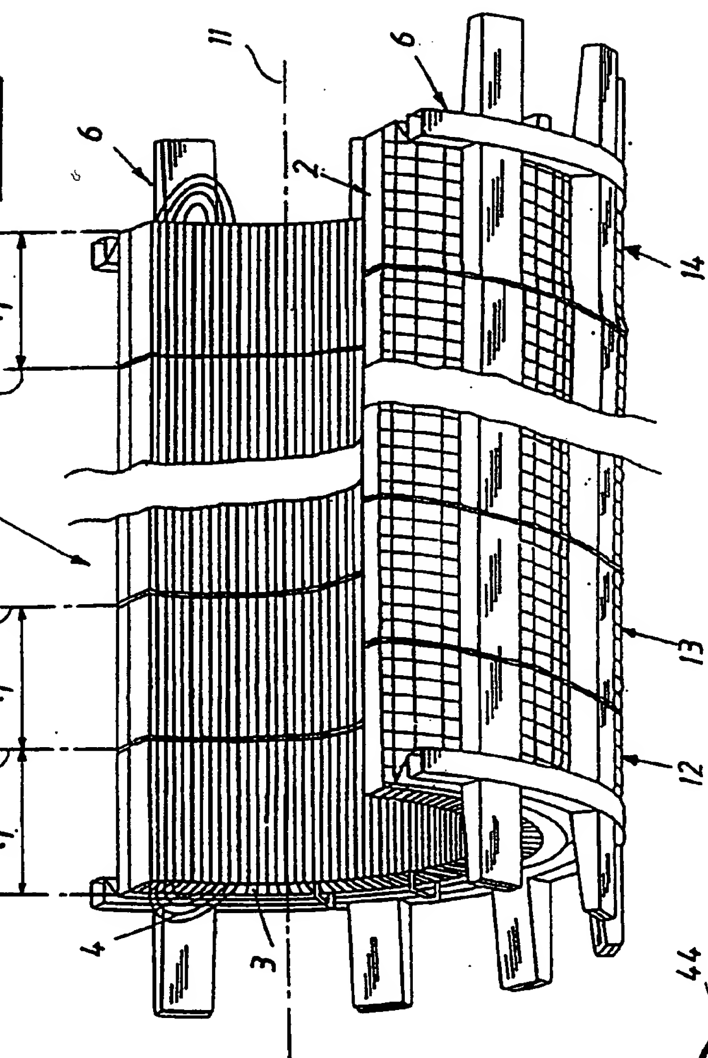
29. A method according to any one of claims 24-28, **characterized** in assembling the stator on the site of installation of the rotating electric machine.

30. A stator for a rotating electric machine, **characterized** in that it is manufactured in accordance with the method in any one of claims 23-29.

31. A rotating electric machine for high voltages, **characterized** in that it comprises a stator as defined in any one of claims 1-22, or 30.

- - - -

Fig. 1



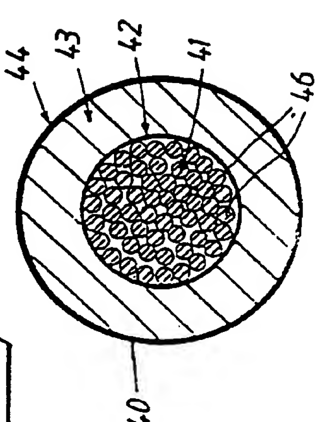


Fig. 4

Fig. 2

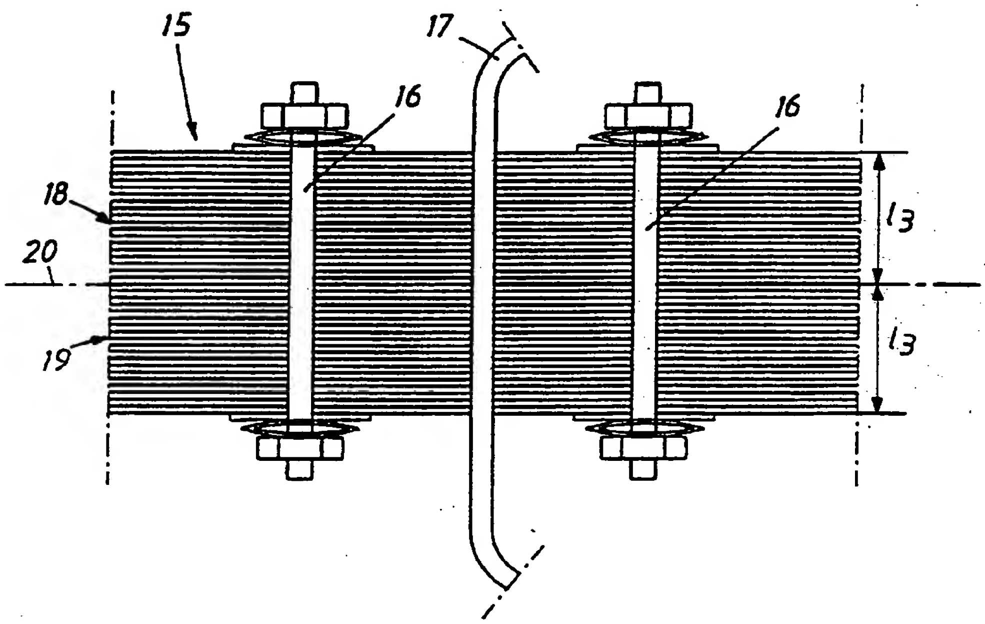
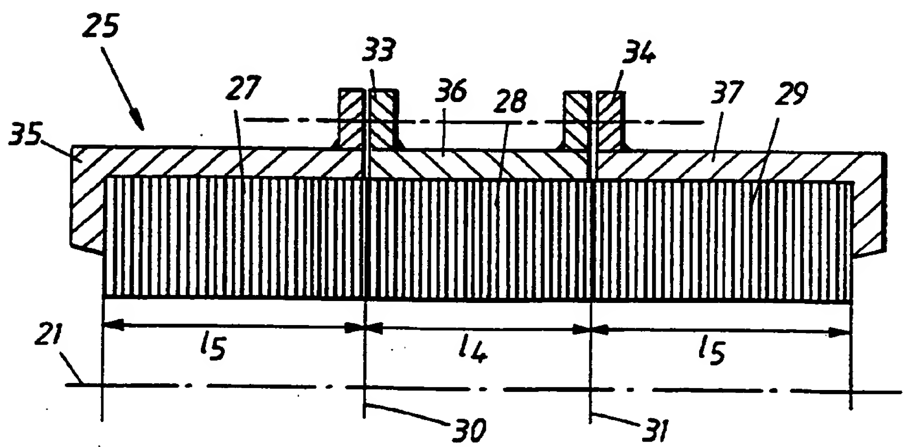


Fig. 3



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/01833

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H02K 15/02, H02K 1/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CH 391071 A (AKTIENGESELLSCHAFT BROWN,BOVERI & CIE, BADEN), 30 April 1965 (30.04.65), column 1, line 11 - line 24 --	1-31
Y	US 4785138 A (O.BREITENBACH ET AL), 15 November 1988 (15.11.88), see the whole document --	1-31
Y	DE 629301 A (HARTSTOFF-METALL-AKT-GES.(HAMETAG)), 9 April 1936 (09.04.36), column 1, line 1 - line 8 --	5,6
A	US 5036165 A (R.ELTON ET AL), 30 July 1991 (30.07.91), see the whole document --	1-31

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

- * Special categories of cited documents:
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- "O" document referring to an oral disclosure, use, exhibition or other means
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- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 December 1998	29 -12- 1998
Name and mailing address of the ISA/ Swedish Pat nt Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Lars Jakobsson Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT
Information on patent family members

01/12/98

International application No.
PCT/SE 98/01833

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CH 391071 A	30/04/65	NONE	
US 4785138 A	15/11/88	DE 3543106 A,C	11/06/87
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US 5036165 A	30/07/91	US 5066881 A	19/11/91
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